the latter figure (TSLRIC per line) which is reported at the bottom of the TSLRIC page.

The model can produce a wide variety of different TSLRIC studies, depending upon the defined increment. For example, you can choose to study the incremental costs of serving residence customers assuming business customers would be served in any event. Conversely, you can choose to study the incremental costs of serving business customers assuming residence customers would be served in any event.

You are not limited to these basic choices, however. By specifying the percentage of customers (market share) in various categories, you can develop a wide variety of different TSLRIC studies. For example, you can estimate the TSLRIC of adding a specific group of residence customers to a network that would otherwise serve business customers and all other residence customers. Do this by specifying the percentage of residence customers served in the two configurations (with a larger percentage in the configuration including the specified group).

Similarly, you can estimate the incremental cost of expanding the network to serve zone two (farther from the central office), by "adding" these customers to a network that would otherwise only serve customers in zone one (nearest to the central office). Such an estimate can be useful in a situation where competitive "cream skimming" is a possibility and the analyst wants to determine the TSLRIC of providing service to customers in the outlying portions of the service area, assuming the carrier would provide service to close-in customers in any event.

Direct, Joint and Common Costs

You must also decide whether to limit the study to direct costs or to include shared (joint and/or common) costs as well. If joints costs are included, you must specify their amount.

Joint costs are a specific type of shared cost--one incurred when production processes yield two or more outputs in fixed proportions. An alternative way of describing joint costs is that, once they are incurred to provide one product or service, they are costlessly available to provide one or more other products or services as well.

The joint cost percentage you select will vary. For a "pure" economic cost study, it would normally be set at 0% for a single service (e.g., local exchange). It would be set at 100% as part of the economic cost of the entire family of services engaging in the joint production process.

In general, common costs are incurred when production processes yield two or more outputs. They are often common to the firm's entire output but can be common to just some parts of it.

The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The percentage selected by the user specifies the allowance for common costs which will be added to the direct and/or joint costs which are estimated by the model.

Network Size

The model will build two networks, each sized to optimally serve the applicable share of the market. Thus, for example, if the user decides to "add" residence service to a network serving business locations, the model will not include any facilities for residence customers in Configuration One, in effect setting the residence market share at 0%. However, you must specify what fraction of the business customers will be served in both configurations and what fraction of the residence customers will be served in Configuration Two. If the user is studying an incumbent monopoly carrier, this would typically be set at 100%, as would the business market shares in both configurations. Of course, when studying the costs faced by a new entrant, a lesser percentage share of the market would normally be appropriate.

You should ensure that the selected percentages are appropriate to the issues being studied, since economies of scale and scope can influence the TSLRIC estimates, although the impact tends to be less dramatic and less predictable than with LRAC estimates (where costs tend to consistently and substantially decline as network size increases).

Total Element Long Run Incremental Cost (TELRIC)

The FCC developed its own version of economic cost for purposes of implementing the 1996 Telecom Act, coining the term TELRIC (total *element* long run incremental cost) to describe the method of economic cost calculation it believes is most appropriate.

> 672. *Overview.* Having concluded in Section II.D., above, that we have the requisite legal authority and that we should establish national pricing rules, we conclude here that prices for interconnection and unbundled elements pursuant to sections 251(c)(2), 251(c)(3), and 252(d)(1), should be set at forward-looking long-run economic cost. In practice, this will

> mean that prices are based on the TSLRIC of the network element, which we will call Total Element Long Run Incremental Cost (TELRIC), and will include a reasonable allocation of forward-looking joint and common costs...

By coining its own term, TELRIC, the FCC has highlighted certain distinctions between its approach to costing network elements and the TSLRIC concept generally applied to telecom services. First, in its Implementation Order, the FCC required that certain shared or common costs be included in TELRIC, even if they do not vary with the presence or absence of the element in question. Since the FCC's requirements in this regard are not consistent with the standard definition of TSLRIC in its pure form, by coining a distinct term (TELRIC) the FCC has avoided some potential confusion in this regard. Second, when the TSLRIC concept is applied to elements (rather than services), the magnitude of the joint and common cost problem tends to be reduced.

TELRIC and TSLRIC are identical in one respect: they are both long run economic cost concepts, using a theoretical planning horizon where most inputs are variable, including the scale and type of plant used by the firm.

To conduct a TELRIC study, the user selects this option on the *Control* page, then pushes the "Establish Parameters and View Results" button. This takes the user to the TELRIC page. Here the user is offered various choices. The user may select an element from a list of several different elements (loops, excluding CPT; loops, including CPT, except NID; customer premises termination (CPT), except NID; network interface devise (NID), port (non-traffic sensitive end office switching); traffic sensitive end office switching; other end office features). The user estimates the incremental cost of adding the element to a network containing all other elements necessary to provide bundled service.

Direct and Common Costs

You must also decide whether to limit the study to direct costs or to include common costs as well. If you wish to include an allowance for common costs (rather than analyze them separately), you must specify the amount. A "joint" cost percentage factor is not required, since the costs in question are directly attributable to specific elements. For instance, a distribution cable jointly used for toll and local service is exclusively attributable to the loop element. It is not jointly used in the production of end office switching.
The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The percentage you select specifies the allowance for common costs added to the direct and/or joint costs estimated by the model.

Network Size

Economies of scale and scope can cause TELRIC estimates to vary widely with the size of the network. As telecom markets become more competitive, it becomes increasingly important to consider how a carrier's costs will be affected by the share of the market its network serves, as well as by the geographic scope of its network. The model will build a network sized to optimally serve whatever portion of the market you specify. Thus, for example, at 100% market share, the model will build a network optimally sized to serve all of the (business and/or residence) customers in the specified geographic area. In contrast, at a lower percentage, the model will build a smaller network, one just large enough to serve the specified share of the total market.

To allow for cost variation within individual wire centers, the model provides for two geographic zones: zone 1 covering the highest density portions (assumed to be in the immediate vicinity of the wire center or end office switch) and zone 2 covering a much larger area, with greater loop lengths and a lower concentration of customers.

The TELRIC cost estimates are displayed at the bottom of this page for the selected wire center. The total cost per line is shown, and the costs may be disaggregated into functional categories or sub elements. Any allowance for common costs you have chosen is shown, as well.

Marginal Cost

Marginal cost is the rate of change in total cost resulting from changes in output. In mathematical terms, marginal cost is the first derivative of the total cost function with respect to output, assuming the cost function is continuous and smooth. In practical applications, the cost function is not necessarily smooth or continuous. Accordingly, it is sometimes necessary to estimate marginal cost over a discrete interval, using smoothing or averaging techniques. When properly applied, marginal cost focuses on the effect of very small changes in output occurring at the point in the total cost curve where the firm is operating and decisions are being made.

To estimate the marginal cost of a service, first select the appropriate option on the *Control* page and push the "Establish Parameters and View Results" button, which takes you to the *LRMCS* page. Follow a similar procedure to estimate the marginal cost of a network element.

Stand-Alone or Combined Costs

You must choose what group's marginal costs to study: single and/or multiline residence and/or business customers. For example, if you wish to estimate the marginal cost of local exchange service on a network serving only residence customers, the model will build a network that serves only residential locations and will scale the facilities to meet the needs of these customers alone. To compute marginal cost, the model will resize the network in a series of iterations smaller and larger than this optimum, or midpoint size. In turn, the model will compute the slope of the total cost curve resulting from this series of computations.

By contrast, if you decide to estimate the marginal cost of local loops on a network that includes both residence and business customers, the model will build a larger, more extensive network of appropriate scale and scope to serve both residential and business locations. To compute marginal cost, the model will resize the network in a series of iterations smaller and larger than this optimum, or midpoint size, based upon variations in the number of business and residence customers served. In turn, the model will compute the slope of the total cost curve resulting from this series of computations, thereby estimating the marginal cost of loops used to serve these customers on a combined network.

Direct, Joint and Common Costs

You must also decide whether to limit the study to direct costs or to also include shared (joint and/or common) costs. In the latter case, you must specify the amount to include in the study.

Joint costs are a specific type of common cost--one incurred when production processes yield two or more outputs in fixed proportions. For a "pure" economic cost study, you would normally set joint costs at 0% for a single service (e.g., local exchange) and at 100% for the entire family of services engaged in the joint production process.

A joint cost percentage factor is not required for the marginal cost of elements, since the costs in question are directly attributable to the element in question. For instance, a distribution cable jointly used for toll and local service is exclusively attributable to the loop element. The cable is not jointly used in the production of something like end office switching.

In general, common costs are incurred when production processes yield two or more outputs. They are often common to the entire output of the firm but can be common to just some parts of that output. The Telecom Economic Cost model does not analyze common costs in detail; it simply adds an allowance for these costs as a percentage of the direct and/or joint costs included in the study. The user-selected percentage specifies the allowance for common costs that will be added to the direct and/or joint costs estimated by the model.

Network Size

As telecom markets become more competitive, it becomes increasingly important to consider how costs are affected by the market share and geographic scope of a carrier's network. The model will build a network sized to optimally serve whatever portion of the market you specify. Thus, for example, if you specify 100% market share, the model will build a network optimally sized to serve all the (business and/or residence) customers in the specified geographic area. In contrast, if you select a lower percentage, the model will build a smaller network, one just large enough to serve the specified share of the total market.

Estimating the Total Cost Curve

In the Telecom Economic Cost Model, marginal cost is estimated by computing the slope of the total cost curve in the vicinity of the specified network size (market share). Once the study parameters have been established, push the "Run LRMC" button. This causes the model to repetitively build a network of varying size, and to estimate the corresponding total cost for each size, thereby estimating the total cost curve for a broad range above and below the volume of output (market share) specified by the user. This process can be quite time consuming, depending upon the user's computer hardware configuration.

Estimation Interval

Because telecom cost are inherently lumpy and non-linear, the slope of the total cost curve can vary depending upon the portion being considered. Accordingly, it is necessary to select the range within which marginal cost is computed. A narrow portion of the total cost curve can be selected, in order to focus the marginal cost estimate within the most immediately relevant range of output. If too narrow a range is selected, the marginal cost estimates may be quite volatile, fluctuating between relatively low and relatively high values, depending upon the size of the carrier and other factors. To increase the stability of the marginal cost estimates, you can select a relatively broad range of output. However, an extremely broad range may not be desirable, since this may result in an estimate of marginal cost which is influenced by data well beyond the relevant range of output. You select the portion of the total cost curve to be evaluated by setting the range in the list box found in the "Smoothing" field on the *LRMCS* and *LRMCE* pages.

Once you have run the model for a specific set of assumptions and wire center, this process need not be repeated to change the specific range within which the slope of the total cost curve (marginal cost) is estimated. Hence, you can quickly evaluate the sensitivity of marginal cost to the specified output (smoothing) range. The resulting cost estimates are shown on the bottom of the *LRMCS* or *LRMCE* page.

Financial and Technical Assumptions

The model includes default values for the cost of materials, labor time requirements, and other underlying relationships and factors. It uses these input values to develop the cost estimates, unless the user substitutes alternative inputs. The default values reflect our general knowledge of the industry, gained over many years of experience working in this field. Since much of this knowledge has been obtained from our review of allegedly proprietary data, it isn't feasible to provide source documents to support these different input assumptions. However, the user can easily verify or modify any of these figures, by referring to a variety of different sources, including invoices, purchase contracts, and special studies, where available.

If you believe an input value is inappropriate or should be modified to improve the accuracy of the cost estimates in a particular context, you can easily change it.. Similarly, if you wish to test the impact of differing assumptions, you can do so by changing the inputs and comparing the results.

Financial Assumptions

Access the financial assumptions by pushing the button so labeled, which takes you to the *Financial* page. Here you have the option of reviewing or changing the financial assumptions used by the model. The blue cells on this page can be varied at your discretion.

Annual Cost Factors

You can control the annual cost factors by adjusting the cost of debt and equity, the equity ratio, and the federal and state income tax rates. You can also specify the economic lives and plant specific charge for various categories of investment. The latter factors are used by the model to estimate the annual cost of maintaining and operating the network.

Loaded Labor Cost per Hour

In this section you can specify the loaded labor cost per hour for engineers and technicians. You should use rates that include wages or salaries, employee benefits and taxes, and other costs that are directly related to the number of labor hours. In this section you can separately specify the additional loading associated with the use of special equipment associated with the following tasks: pole installation, trenching, trenching through man-made obstacles, and manhole installation.

Interoffice Trunking

You can specify the electronics investment in interoffice trunking per 64-bit channel for two levels of lumpiness: DS1 and DS3. You can also specify other interoffice investment per local channel and per switched access channel. These investment amounts are specified on an engineered, furnished, and installed (EF & I) basis.

Loop Fiber Electronics

You can separately specify the material costs of fiber electronics used to provision local loops over fiber optic cable at both the wire center and the remote location. At both locations, you can specify the fixed, minimum cost of the system (not including any channel capacity), and the variable cost associated with increases in the size of the system. The latter costs are specified through a table that allows you to capture any economies of scale that exist in the cost of this equipment. The model uses this information to estimate the material cost of a complete system of the required size. Depending upon the input values selected, you can model a specific type of system, or you can model the overall array of systems that are available from various manufacturers.

Billing and Collecting

Billing and Collecting costs are segmented into direct costs and joint costs. Joint billing and collection costs include bill handling, envelopes, and minimum postage. Direct billing and collection costs include centralized mail remittance, customer service, bill inquiry, and data processing.

Outside Plant Structures

In this section you input the loaded investment in materials required for aerial and underground structures. Aerial investment is specified on a per pole basis. You can specify the materials cost of handholes, manholes, and underground vaults, using both fixed and variable inputs. Where a mixture of different sizes and types of manholes are used, the selected inputs should be consistent with the average cost of the various types of facilities. The variable component allows you to model the higher cost associated with larger cable cross sections, which are more difficult to physically deal with, and more likely to require a larger size manhole or vault.

The materials cost of underground conduit is specified in a similar manner, on the basis of a fixed amount per foot and a variable amount per cable pair per foot. The variable component allows you to model the increase in cost which results from larger cable sheath sizes and/or multiple sheaths.

You can also specify the additional cost of installing sod on top of buried and underground installations, in those situations where such replacement is required or appropriate.

Switching

In this section you control the investment in switching facilities. These investment amounts are specified on an engineered, furnished, and installed (EF & I) basis, and the total investment is built up through a series of subcategories. These include building and other miscellaneous investments, as well as distinctions between traffic-sensitive and non- traffic-sensitive facilities.

The traffic sensitive investments are specified as a function of call setup (per hundred calls/day) and as a function of minutes of use (per hundred minutes/day). You can also provide an allowance for right to use fees and other costs of providing switching features such as custom calling, rotary, caller ID, voice mail, and the like. The model does not estimate these costs in detail; they are simply input on a per line per month basis.

Feeder and Distribution Investment

You can specify the delivered material cost per sheath foot for investments in both copper and fiber cable. Separate inputs are available for aerial, underground, and buried cable. You can also provide an allowance for additional cable related investments that are not incurred on a per foot basis.

For instance, you can include a portion of the investment in the wire center Building and the Main Distributing Frame as loop related, taking care to ensure that the same costs are not included in the switching investment inputs. Similarly, these inputs provide an additional allowance for the material cost of Cross Connects, in line pedestals, load coils and other miscellaneous items, to the extent these costs are not included in the material cost inputs for the cable itself.

Customer Premises Termination

You can specify the E F & I investment in Drop Wire/Building Cable, as well as the Remote Terminal and the Network Interface Device (NID).

Technical Assumptions

To access the technical/engineering assumptions, push the button labeled "Technical Assumptions," which takes you to the *Technical* page. The following is a brief description of key inputs on this page. You can change the cells with blue shaded backgrounds.

Utilization Factors

To size facilities, the model uses separate utilization factors for Customer Premises Facilities, Fiber Electronics, and Switching Equipment, and various categories of cable. Use of these factors ensures that an adequate amount of spare capacity is available for administrative purposes and to respond to changes in customer location and mix. A long-run study would normally use relatively high (idealized, or optimum) utilization rates, consistent with the underlying concept of a long-run planning horizon, in which factory size is adjusted to accommodate the anticipated volume of production.

Note that the effective fill factor (actual ratio of working facilities as a percentage of total installed capacity) as developed within the model takes into account the lumpiness of specific facilities. Thus the fill factor will generally be less than the utilization rate that you input. You can conveniently observe the effective cable fill factor by pushing the button labeled "Wire Center Characteristics" at the top of the screen. This takes you to the *Wire Center Characteristics* page, where this information is displayed.

Sharing Factors

These variables specify the extent to which the carrier is assumed to share structure costs (e.g., poles, conduit, and trenches). If the carrier will not install all its own poles but will rent space from another firm (e.g., an electric utility), a factor below 100% would be appropriately selected. Similarly, if the carrier can rent pole attachment space to others (e.g., to a cable TV carrier), this variable can be used to recognize this source of revenue as an offset to the cost of the pole. In most cases, only a fraction of the full cost of poles should be included in the cost study--particularly in the case of smaller entrants, which should often be able to attach their facilities to the incumbent's poles.

Calling Volume

These variables allow you to specify the number of calls per month and the average call duration. These data are input separately for local calls and switched access calls. Toll calling volumes are included in the switched access category. The numbers of calls per month and the average duration will typically vary with the type of customer (e.g., residence, single line business, and multiline business).

Loop Network Technology

These variables determine the mix of fiber optic and copper cable in the modeled network. You can specify an all-copper network, an all-fiber/digital network, or a combination. These assumptions can be selected for each wire center, based upon the minimum cost configuration, an engineering convention, marketing considerations, or any other basis. Thus, for example, an all-fiber network could be selected if the subject carrier is positioned in the market as an all-digital carrier, even if this configuration does not yield minimum cost.

In a long-run study, most production factors are variable, and the optimal, most cost-effective options would normally be assumed--those options that result in the lowest total cost for the relevant level of output. The choice of technology, however, will not necessarily result in the lowest marginal or incremental cost for every service. For example, fiber optics may be selected, if this technology sufficiently reduces the cost of providing video services or broadband data services, even if it increases the cost of other services.

In practice, technology decisions are often driven by marketing and other considerations, in addition to cost minimization in the purest sense. Accordingly, you can adjust the model to simulate a variety of different copper/fiber plant configurations and observe the resulting impact on the average cost and total service incremental cost of serving both residence customers and business customers.

The model provides you with the flexibility to prepare cost estimates using three distinct sets of assumptions regarding loop technology. The first (all copper) builds a network composed entirely of traditional analog copper cable. The second builds a loop network almost entirely composed of fiber cable, with copper in the final segment of distribution cable and the drop wire/building cable at the customer's premises. The third option builds a mixed copper and fiber network, with the precise mix varying by wire center, based upon the minimum fiber length, maximum copper length, and the minimum number of loops served by the remote terminal containing the fiber electronics, as explained below.

When you choose a network configuration using both fiber and copper technology, you should specify the mix in keeping with the economic factors that control this technology choice. In general, copper cable is more cost effective where the number of loops is relatively low or loop lengths are relatively short. The model will deploy as much fiber optic cable as possible, subject to three constraints: a minimum fiber distance, a minimum number of lines served by each remote terminal, and a maximum length of copper distribution cable beyond the remote terminal. The latter variable can be used to avoid the necessity for installing thicker gauge copper wire, or load coils, or to ensure adequate quality for enhanced services like ISDN. All three criteria can be controlled by the user. It should be noted, however, that the model always deploys copper in the final segment of distribution cable (connecting to the drop wire/building cable at the customer's premises). As modeled, this segment represents the final 7% of the loop length.

Customer Dispersion Factors

The model takes into account at least one important complication often overlooked in other models: it recognizes that systematic differences in population density may lead to cream-skimming by new entrants. It does this by incorporating a two-zone density taper (zones 1 and 2). The inner zone would normally contain a higher density of loops per square mile, based upon the assumption that the most efficient plant configuration will site the central office as close as possible to the population center, in order to minimize the average loop length. You can control this aspect of the model using four kinds of customer dispersion factors.

The first input controls the percentage of wire center loops that terminate in zone one. Since zone 1 contains 25% of the geographic area served by the wire center, an input value above 25% specifies higher than average loop density in this zone. For example, with an input value of 33%, the model builds a network in which one-third of the loops are located in one-fourth of the geographic area. In contrast, a setting of 25% specifies that the loops are equally distributed (i.e., one-fourth of the loops within one-fourth of the area).

The second customer dispersion factor controls the extent to which business loops are more heavily concentrated than residential loops in zone 1. This factor is additive to the first input, thereby controlling the fraction of business loops within each of the two zones. Thus, for example, if this factor is set at 10% while the first factor is set at 33%, the model places 43% of the business loops in zone 1 (one fourth the geographic area) and the remainder in zone two. Because zone 1 locations are closer to the wire center and have shorter loop lengths, this variable controls the average length of business loops, relative to the average length of residence loops.

Due to zoning regulations and other factors, business and residence customers are not necessarily uniformly dispersed along each cable route. The third dispersion factor controls the models ability to reflect this factor, by modeling the extent to which business customers and residence customers clustered near each other, and thus are likely to be served by particular cable segments. Caution should be used in modifying the default values for these inputs, to ensure that the model is appropriately reflecting the degree of clustering which is being modeled.

Residence Line Ratios

You can specify the percent of households with phone service (penetration rate), and the average number of single-line residence loops as a percentage of total residence loops. You would normally use census or other data concerning typical penetration rates to set the first of these blue input cells. You can use the second blue cell to specify the ratio of single lines to total residence lines (including lines going to households with two or more lines). You can use the two blue cells in tandem to adjust the non-blue cells. The first of these cells reports the ratio of residence loops to the total number of households in the geographic area served by the wire center. The second reports the ratio of residence loops to the total number of households with phone service. The model uses the first non-blue cell (labeled "Residence loops per household") to establish the total number of residence lines served by the wire center, based upon data concerning the number of households, imported into the model from a separate data file.

To learn more about the loop characteristics developed by the model, push the button labeled "Wire Center Characteristics" at the top of the screen. This takes you to the *Wire Center Characteristics* page, where data is displayed concerning the number of business and residence loops.

Business Line Ratios

You can specify the percent of single-line business lines relative to the total number of business lines. You can vary these input cells based upon the specific characteristics of the wire center (where known), or use an average value from an general data source such as ARMIS.

Miscellaneous Switching Characteristics

These input cells allow you to specify the proportion of calls placed to other end offices (interoffice calls) relative to the number of calls that originate and terminate in the same end office (intraoffice calls). Similarly, you can specify the fraction of calls handled by a tandem switch, and the average monthly minutes of use handled by each interoffice trunk. You can vary these input cells based upon the specific characteristics of the wire center (where known), or use a generic or average value.

Fiber Capacity

The fiber capacity inputs allow you to specify the maximum number of loops which can be derived from a single fiber pair, consistent with any limitations that are assumed to exist on the speed of the lasers, consistent with the types of systems, and associated costs, that are being modeled. You can also specify the amount of fiber to be deployed for redundancy (reliability) purposes. In addition, a fiber safety reserve can be specified, stated as percentage of the required amount of fiber and a minimum number of extra pairs per segment. The model uses these inputs, along with the utilization rate, in determining the effective fill factor for fiber cable.

Fiber Electronics

The fiber electronics cells allow you to separately specify the labor requirements for the design, engineering, and installation of the fiber electronics used at the wire center and the remote location. Both fixed and variable inputs are provided, to reflect the fact that larger, more complex systems are more time consuming to design and install.

Splicing

You can specify the number of minutes required for splicing of copper and fiber cable, stated in minutes per segment, minutes per pair, and minutes per pair per kilofoot. All three variables are used by the model in determining the total splicing labor requirements.

The time and effort required for the installation of support structures can vary widely, depending upon numerous different factors. Each of these labor inputs can be individually adjusted, as described below.

The aerial and underground percentages of feeder, feeder/distribution, and distribution structures are input by the user in the appropriate blue input cells. The buried percentages are residual. The underground percentages of these three segments require two inputs each. In mathematical terms, the percentage of underground structures can be thought of as a function of a proxy variable representing degree of urban density (the first blue cell) and a constant (the second blue cell). The model uses the first blue cell in conjunction with the number of residence and business lines in the market area served by the wire center, to determine the net percentage of underground placement in the wire center. In selecting these percentages, you have three choices: (1) to use generic values taken from an external data source such as ARMIS; to develop specific percentages for each wire center, based on local conditions; or (3) to select percentages that minimize cost, given the constraints imposed by zoning ordinances and other local conditions.

Structures

The engineering and labor hours for aerial structures are set per pole by the user, as is the distance (in feet) between poles.

Where soil conditions make pole installation either difficult or very difficult, the added labor time per pole can be specified.

Since underground placement tends to be costly, this option is generally avoided. However, underground structures are desirable or mandatory in at least three types of locations: highly urbanized areas (due to the presence of man made obstacles such as concrete sidewalks and busy city streets), in areas where aerial installation is not allowed or feasible, in areas where a high water table makes direct burial impractical, and in any area where trenching costs are very high. In the locations where trenching is costly but aerial installation isn't a viable option, the additional cost of placing conduit may be justified in order to facilitate future growth and expansion of the network (since additional cable can be pulled through spare conduit in future years without the necessity of digging another trench). Hence, the percentage of underground structures should be higher in relatively dense, more urbanized wire centers, and in those non-urban locations where aerial placement is prohibited and direct burial is unusually costly (e.g., due to rocky conditions).

For either underground or buried cable and conduit, the user may separately specify a trenching/plowingdepth of either 36 or 24 inches for copper and fiber, differentiating between feeder, feeder/distribution, and distribution segments. Farther from the wire center, where fewer customers would be affected by a cable cut, a shallower depth may be acceptable.

You may also specify the labor required for these installations, specified in minutes per running foot for each depth. The user may also specify the additional labor required due to various conditions: (1) difficult or very difficult soil conditions (e.g. the presence of rock); (2) groundwater conditions; (3) man-made obstacles like concrete, asphalt, water lines or sewer lines. The portion of the run that encounters man-made obstacles can also be specified, both as a function of density and as a function of other factors.

Engineering hours per mile, which will typically be greater for underground than for buried cable, can also be specified, as can key factors that influence the cost of these installations, such as the average spacing of manholes, and the time required for installation of these facilities.

Cable Sheaths

Designing or placing two or more sheaths of cable at the same time can create cost savings relative to the requirements when designing or placing the same number of sheaths at different times or along different routes. These input cells allow you to specify the magnitude of the cost savings when multiple sheaths are simultaneously designed and placed along a single route. For example, if the number of engineering hours required for two cable sheaths is the same as for one sheath, the engineering variable would be set at -100 %. Similarly, if second and subsequent sheaths can be placed with 70% less labor than required for a single sheath, the placement cell would be set at -70%. The model uses these inputs only on routes where multiple sheaths are required by the network design.

Cable Design and Placement

You can input the design and engineering hours per kilofoot for aerial, underground, and buried copper and fiber cable. You can also specify the labor requirements per kilofoot for placement of aerial, underground, and buried copper and fiber cable.

Customer Premises Termination

You can specify the drop wire/building cable average length and installation time per pair and per foot. You can set different values for these inputs for residence and business premises.